10 Noise

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10 Noise

10.1 Executive Summary

10.1.1 This chapter considers potential noise effects associated with construction and operation of the Proposed Development. No potential vibration effects have been identified and consideration of vibration has therefore been scoped out. It is anticipated that decommissioning will be required, and the associated noise effects would be similar to, but lesser than, construction phase effects.

10.1.2 The assessment of noise has comprised consultation with Orkney Islands Council (OIC) Environmental Health Department, characterisation of the baseline noise environment, prediction of noise levels associated with construction activities, construction traffic, operation of wind turbines and operation of other non-turbine fixed plant, and evaluation of predicted levels against derived criteria.

10.1.3 Noise effects from construction, including on-site activities and construction traffic, were found to be not significant. Noise effects from fixed non-turbine plant have been determined to be not significant.

10.1.4 The Applicant has committed to noise levels associated with operation of the Proposed Development meeting the development-specific noise limits to be agreed through the consenting process at all Noise Sensitive Receptors (NSRs). Where necessary, this may require a noise management plan to be put in place.

10.2 Introduction

10.2.1 This chapter provides an assessment of the potential effects of the Proposed Development on receptors sensitive to noise during the construction, operation and decommissioning phases.

10.2.2 This assessment has considered the development layout as described in **Chapter 3**. We note that the Proposed Development turbines will not exceed 180 m to blade tip and this assessment has been undertaken on this understanding. The candidate turbine that has been used to inform the assessment has a hub height of 102 m and rotor diameter of 155 m. The candidate turbine considered as part of this assessment is the Siemens Gamesa SG155 6.6 MW.

Scope of Assessment

10.2.3 The scope of this chapter has comprised the following:

- scoping consultation with Orkney Islands Council (OIC) Environmental Health Department;
- evaluation of noise effects associated with operation of the Proposed Development;
- specification of appropriate mitigation, where necessary; and
- evaluation of residual effects.

Effects Scoped Out

10.2.4 Given the separation distances involved between potential vibration sources and sensitive receptors of greater than 200 m, vibration associated with construction and operation of the Proposed Development at the closest sensitive receptors will be negligible, therefore vibration has been scoped out of further assessment.

10.2.5 Traffic flows associated with the operational phase of the Proposed Development will be negligible (on average <1 vehicle movement per day), therefore operational road traffic noise has been scoped out of further assessment.

About the Author

10.2.6 This chapter has been written by Simon Waddell BSc (Hons) MIOA. Simon is an acoustics consultant with more than ten years' experience of wind farm noise assessments. He is a full member of the Institute of Acoustics.

10.2.7 The chapter has been reviewed by Alasdair Baxter BSc (Hons) Dunelm, MSc, MIOA. Alasdair is a full member of the Institute of Acoustics and has over 19 years' experience in environmental noise assessment.

10.3 Legislation, Policy and Guidelines

10.3.1 Relevant legislation and guidance documents have been reviewed and taken into account as part of this assessment. Legislation of particular relevance is outlined below.

10.3.2 In lieu of any specific legislation, assessing the effect of such a development during the construction, operational and decommissioning phases must draw on information from a variety of sources. This assessment therefore makes reference to a number of British Standards, official planning policy and advice notes and national guidance.

Legislation

10.3.3 For a development of this nature, there is no specific all-encompassing legislation relating to the standards associated with noise emission/effects. Noise legislation, where it does exist, tends to be either EU-derived and focussed on specific items of noise-emitting plant or on more general nuisance, such as that addressed by the provisions of the Environmental Protection Act 1990 (UK Government, 1990).

Environmental Protection Act 1990

10.3.4 Section 79 of the Act defines statutory nuisance with regard to noise and determines that local planning authorities have a duty to detect such nuisances in their area and, where a complaint of a statutory nuisance is made to it by a person living within its area, to take such steps as are reasonably practicable to investigate the complaint.

10.3.5 The Act also defines the concept of "Best Practicable Means" (BPM):

- 'practicable' means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;
- the means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;
- the test is to apply only so far as compatible with any duty imposed by law; and
- the test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances.

10.3.6 Section 80 of the Act provides local planning authorities with powers to serve an abatement notice requiring the abatement of a nuisance or requiring works to be executed to prevent their occurrence. It is a potential defence against failure to comply with an abatement notice where BPM were used to prevent or counteract the effects of the nuisance.

Planning Policy

Scottish Government Online Planning Advice: Planning Advice Note 1/2011 and Technical Advice Note

10.3.7 Published in March 2011 and last updated in 2014, Planning Advice Note 1/2011 (Scottish Government (2014b)) (PAN 1/2011) provides advice on the role of the planning system in helping

to prevent and limit adverse effects of noise. Information and advice on noise assessment methods are provided in the accompanying Technical Advice Note: Assessment of Noise (Scottish Government (2011b)) (TAN). Included within the PAN document and the accompanying TAN are details of the legislation, technical standards, and codes of practice for specific noise issues.

10.3.8 Regarding noise from wind turbines, paragraph 29 of PAN 1/2011 states the following:

"There are two sources of noise from wind turbines – the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU R 97) published by the former Department of Trade and Industry (DTI) and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise."

10.3.9 Regarding appropriate assessment methods, the 'web-based planning advice' referred to in PAN 1/2011 is contained in an online document titled '*Onshore Wind Turbines*', published by the Scottish Government (updated 2014). The document is summarised in the corresponding section below, and also refers to the use of ETSU-R 97. The Assessment and Rating of Noise from Wind Farms (The Working Group on Noise from Wind Turbines, 1996) assessment guidance (discussed in paragraphs 10.3.17 to 10.3.30).

10.3.10 The Institute of Acoustics (IoA) has since published '*a Good Practice Guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise*' (IoA, 2013), which is summarised in paragraphs 10.3.31 to 10.3.39. The Scottish Government accepts that the guide represents current industry good practice.

10.3.11 Neither PAN 1/2011 nor the associated TAN provide specific guidance on the assessment of noise from fixed plant, but the TAN includes an example assessment scenario for '*New noisy development (incl. commercial and recreation) affecting a noise sensitive building'*, which is based on BS4142:1997: '*Method for rating industrial noise affecting mixed residential and industrial areas*'. This British Standard has been superseded by BS4142:2014+A1:2019 '*Methods for rating and assessing industrial and commercial sound*' (BSi, 2019). The standard is summarised in paragraphs 10.3.52 to 10.3.57.

10.3.12 In summary, national planning policy on the assessment of operational noise impacts from wind farms stipulates the use of the ETSU-R-97 assessment method and application of the IoA Good Practice Guide (IoA GPG). These guidance documents, and others relevant to the assessment of possible noise impacts generated by the Proposed Development, are summarised below.

Onshore Wind – Policy Statement Refresh 2021: Consultative Draft

10.3.13 The Scottish Government has provided a consultative draft ('the draft') seeking views on how to tackle barriers to deployment of wind turbines and securing the maximum economic benefit from developments.

10.3.14 Regarding noise the draft notes that noise is a potential environmental barrier to deployment and identifies that ETSU-R-97 may be outdated and is under review. The draft further identifies that public concern about wind turbine noise is increasing despite a lack of empirical evidence for any adverse health impacts.

Regional and Local Planning Policy

10.3.15 Local planning policy is discussed in **Chapter 5** of this EIA Report.

Guidance

10.3.16 This assessment has taken cognisance of the following best practice guidelines and guidance.

ETSU-R-97: The Assessment and Rating of Noise from Windfarms (ETSU-R-97)

10.3.17 As referenced for use in PAN/2011 and the online planning advice for renewable technologies: Onshore wind turbines, this document was written by a Noise Working Group including developers, noise consultants and environmental health officers, set up in 1995 by the Department of Trade and Industry through ETSU (the Energy Technology Support Unit).

10.3.18 ETSU-R-97 presents a consensus view of the working group and was prepared to present a common approach to the assessment of noise from wind turbines. The document states that noise from wind turbines or wind farms should be assessed against site specific noise limits.

10.3.19 Noise limits are derived based on a series of acceptable lower limits and based on an allowable exceedance above the prevailing background noise level, including consideration of a variety of different prevailing wind speed conditions. The noise limits should be derived for external areas used for relaxation, or areas where a quiet noise environment is highly desirable. Separate limits are required for night-time and daytime periods. Night-time limits are derived drawing upon measured night-time background noise levels, whilst daytime limits are derived drawing upon the background noise levels arising during 'quiet daytime' periods.

10.3.20 Night-time is defined as the period between 23:00 and 07:00 hours, whilst quiet daytime periods are defined as:

- 18:00 to 23:00 hours on all days;
- 13:00 to 18:00 hours on Saturdays and Sundays; and
- 07:00 to 13:00 hours on Sundays.

10.3.21 For daytime, the suggested limits are 5 dB above the prevailing background noise level determined during quiet daytime periods, or 35 to 40 dB(A), whichever is the higher. The absolute criterion between the 35 to 40 dB(A) range is selected taking account of:

- the site environs (e.g. number of local receptors);
- the energy generation capacity (e.g. number of kWh that can be generated) of the proposed development; and
- the associated duration and level of exposure.

10.3.22 During night-time, the suggested limits are 5 dB above the prevailing night-time background noise level or 43 dB(A), whichever is the higher. The absolute criterion for the night-time is higher than that for the daytime, as the derivation of this limit is based on preventing sleep disturbance within a building whereas for the daytime, limits are based on occupation of external spaces used for relaxation.

10.3.23 It is required that the prevailing background noise levels be determined in terms of the $L_{A90,10min}$ noise index for both quiet daytime and night-time periods, for wind conditions ranging from 2 ms-1 to 12 ms-1.

10.3.24 The noise limits are calculated by undertaking a regression analysis of the $L_{A90,10min}$ noise levels and the prevailing average wind speed for the same 10-minute period, when measured or determined at 10 m above ground at the location of the proposed turbines. The allowable limit is then defined at +5 dB above the average noise level at each wind speed (as defined by the regression analysis), or the absolute noise level lower limit, whichever is the higher (assuming no financial involvement within the scheme).

10.3.25 ETSU-R-97 also provides a simplified noise limit of 35 $dBL_{A90,10min}$ which may be applied to avoid the need to measure background noise levels and derive. The 'simplified ETSU limit' typically applies both during the daytime and night-time period.

10.3.26 Where a property has a financial involvement in the scheme, the document allows a relaxation of the derived noise limits, stating that "*It is widely accepted that the level of disturbance or annoyance caused by a noise source is not only dependent upon the level and character of noise but also the*

receiver's attitude towards the noise source in general. If the residents at the noise-sensitive properties were financially involved in the project, then higher noise limits will be appropriate". The guidance goes on to state that it is "*recommended that both the day and night-time lower fixed limits can be increased to 45 dB(A) and the consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the windfarm*". The amount by which the permissible margin above background can be relaxed is not specified, but the allowable relaxation to 45 dB(A) of the lower limits is an increase of (at least) 5 dB during the daytime and 2 dB during the night-time, so similar levels of relaxation might also be applied to the background related element of the noise level limits.

10.3.27 The ETSU guidance states that the derived limits should be applied to noise from the proposed wind farm or turbines in terms of the $L_{A90,T}$ index, and that the $L_{A90,T}$ of the wind farm noise is typically 1.5 to 2.5 dB lower than the $L_{Aeq,T}$ measured over the same period.

10.3.28 The derived noise limits are applicable to both the aerodynamic (e.g. 'blade swish') and mechanical (e.g. generator related) components of wind farm noise.

10.3.29 Where noise from the wind farm is tonal, a correction of between 2 and 5 dB is to be applied to the wind farm noise. Guidance is provided on how to determine the level of correction required, but typically, for proposed developments, the need for any applicable correction is confirmed by the independent wind turbine-specific noise tests, following standard test procedures, provided by manufacturers.

10.3.30 It is stated within the ETSU guidance that "*The Noise Working Group is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question. It is clearly unreasonable to suggest that, because a wind farm was constructed in the vicinity in the past which resulted in increased noise levels at some properties, that residents of those properties are now able to tolerate still higher noise levels. The existing wind farm should not be considered as part of the prevailing background noise*". Accordingly, where an existing wind farm contributes to the prevailing background noise levels, it is necessary to either include for the contribution of this wind farm when comparing against the allowable noise limit or correct for this contribution when deriving a limit applicable to the proposed development acting alone.

Good Practice Guide to the Application of ETSU-R-97 (IoA GPG)

10.3.31 The IoA GPG presents the report of a 'noise working group' (NWG) assembled in response to a request from the former Department of Energy & Climate Change (DECC). The guide is intended to represent current good practice in applying the ETSU-R-97 method to assessing the noise impact of wind turbine developments with a power rating of over 50 kW.

10.3.32 In addition to detailed consideration of various issues and factors concerned with current 'state of the art' knowledge of UK wind turbine noise assessment, a series of 'summary boxes' (SBs) highlighting key guidance points are included.

10.3.33 The SBs provide clarification and updated guidance on a range of matters relating to ETSU R-97 noise assessments, including consultation with relevant stakeholders, background noise survey methodology, noise survey data analysis, derivation of noise limits, noise prediction model input data, algorithms and parameters, cumulative impact assessment procedures, assessment reporting, planning conditions and amplitude modulation. A set of supplementary guidance notes (SGNs) also form part of the publication and include further specific detail for different technical areas.

10.3.34 The detail of the IoA GPG has been considered in the preparation of this assessment. Some of the key considerations relevant to this assessment are summarised as follows:

- Background noise surveys should be carried out for sufficient duration to obtain a suitably-sized dataset; as a guideline, it is suggested that no less than 200 data points be obtained within each of the night-time and amenity hour periods for a given survey location, with no less than five data points within each contiguous wind speed integer interval (for pitch regulated turbines, up

to the wind speed at which the maximum sound power level is reached. Where the data has been filtered by wind direction the guideline values are reduced.

- Background noise survey data should be analysed, and anomalous periods of noise removed from the dataset; anomalous noise might include rain-affected periods and increased noise from water courses following rainfall, seasonal effects such as early-morning birdsong ('dawn chorus'), atypical traffic movements and other unusual noise sources affecting measured levels.
- Due to the potential for non-standard site-specific wind shear (i.e. differences in wind speed at different heights above the ground – a 'standard' profile increases logarithmically with height) background noise levels should be correlated with 10 m height wind speeds derived using a method that 'standardises' the wind speeds using the assumed shear profile. Since wind turbine sound power levels are determined using the same shear profile, this procedure ensures a link between the predicted sound levels at a given hub height wind speed and the background noise levels at receptors near the ground under the same wind speed conditions (obtained using the 'standardised' 10 m height wind speed).
- Derivation of the prevailing background noise levels should be carried out using polynomial regression analysis, of order one to four, depending on the nature of the noise environment. The regression curve used should reach minimum and maximum values at the lowest and highest wind speeds for which the dataset is valid, respectively.
- Calculations of predicted wind turbine noise may be carried out using ISO 9613 2: Acoustics – Attenuation of Sound during Propagation Outdoors (International Organization for Standardization, 1996); preferred receptor heights, meteorological and ground absorption input parameters for this calculation procedure are given.
- Turbine sound power level source data should include appropriate uncertainty corrections. Guidance is given for determining when such uncertainty corrections have been inherently included in turbine source emission data.
- A correction for topographic screening of a maximum -2 dB may be applied where there is no line of sight between the turbine (tip) and the receptor (4 m above ground level).
- A correction for constructive reflection within valleys of +3 dB should apply where concave topography is determined to lie between the turbine and the receptor point.
- 'Excess amplitude modulation' (i.e., where the wind turbine noise has higher variability with momentary time than the 2 – 3 dB(A) considered within ETSU-R-97) is still the subject of research; current practice (at the time of publishing of the IoA GPG) in relation to determining applications for wind turbine developments is to not impose a planning condition specific to this phenomenon.

10.3.35 In addition to the above, the IoA GPG confirms that the ETSU-R-97 noise level limits should be applied cumulatively and provides guidance on appropriate assessment methods for a variety of different cumulative scenarios. These scenarios include *'concurrent applications'*, *'existing wind farm consented with less than total ETSU-R-97 limits*', '*existing wind farm/s consented to the total ETSU-R-97 limits currently operating'*, and '*permitted wind farms consented to total ETSU-R-97 limits but not yet constructed*'.

10.3.36 In the section titled '*existing wind farm/s, consented to the total ETSU-R-97 limits, currently operating*' it is stated that "*In the first instance, the consented noise limits should be used within the cumulative noise impact calculations unless otherwise agreed with the local authority. Provided the sum of the noise limits derived for the proposed site when added to those already consented for the operational sites does not exceed the limits that would otherwise be within the requirements of*

ETSU-R-97 for the cumulative impact, then the noise limits derived for the proposed site can be applied directly".

10.3.37 In practical terms this can be achieved by ensuring that the noise limit for the Proposed Development is set 10 dB or more below that permitted to be generated by the existing development.

10.3.38 It is, however, then discussed that this may not always be necessary, e.g. where there is a 'controlling property', whereby compliance with the noise limit at that controlling property would result in noise levels never realising the noise level limit 'in full' at another property (e.g. because the second property is further removed from the existing development), thereby leaving a proportion of the limits available for use at the second property by the subsequently proposed development. Another reason that is discussed is where there is no realistic prospect of the existing wind farm producing noise levels up to the consented limit, again thereby leaving a proportion of the limit available for the subsequently proposed development.

10.3.39 The process provided in the IoA GPG for determining appropriate noise limits applicable at specific properties is summarised as follows:

- Identify cumulative developments, i.e., those from which the predicted level at properties within the study area are within 10 dB of the Proposed Development. Developments from which the predicted level is 10 dB or greater different to that of the Proposed Development may be scoped out of further analysis.
- Determine the consented noise limits for other developments applicable at properties where cumulative effects may occur.
- Predict noise levels from cumulative developments and identify controlling properties (typically those closest to the specific wind farm/turbine without financial involvement; assuming compliance with noise limits at these properties will limit the maximum noise level possible at more distant properties).
- Confirm that the predicted levels from cumulative developments do not exceed noise limits at controlling properties.
- Identify whether 'significant presented headroom', equivalent to a difference of +5 dB or more between the predicted level and the consented noise limit, is available at properties.
- Where significant presented headroom is demonstrated, the noise limit at the property can be determined by subtraction of a 'cautious prediction' of the predicted level from cumulative developments +2 dB, from the consented noise limit.
- Where no significant presented headroom is available, the noise limit at the property is set at 10 dB below the applicable overall noise limit.

Design Manual for Roads and Bridges (DMRB) – chapter LA111 Noise and Vibration

10.3.40 DMRB provides standards and advice regarding the assessment, design and operation of roads in the UK. DMRB provides screening criteria, by which percentage changes in traffic flow can be related to a predicted change in road traffic noise and vibration. The guidance also provides significance criteria, by which the percentage of people adversely affected by traffic noise can be related to the total noise or vibration level due to road traffic, or the increase over an existing level.

10.3.41 DMRB provides a method for predicting the Basic Noise Level (BNL), a measure of the source noise level of a road. The BNL is a function of the composition, flow and speed of traffic and the quality of the road surface. Changes in the BNL, arising from changes in traffic flow, may be used as a means of determining the significance of operational noise effects.

10.3.42 The following scoping criteria are provided for the evaluation of operational noise from a road:

- Is the project likely to cause a change in the BNL of 1 dB LA10,18hour in the do-minimum opening year (DMOY) compared to the do-something opening year (DSOY)?;
- Is the project likely to cause a change in the BNL of 3 dB LA10,18hour in the do-something future year (DSFY) compared to the DMOY?;
- Does the project involve the construction of new road links within 600 m of noise sensitive receptors?; and
- Would there be a reasonable stakeholder expectation that an assessment would be undertaken?

10.3.43 Regarding a 'reasonable stakeholder expectation' for an operational noise assessment, DMRB notes an example where works involve changes to infrastructure but are not expected to give rise to significant environmental effect, such as smart motorway projects.

10.3.44 Where the response to any of the above scoping questions is 'yes' the scoping assessment shall make a recommendation on the scope of further assessment.

BS5228:2009+A1:2014 – Code of practice for noise and vibration control on construction and open sites – Part 1 (noise) and Part 2 (vibration)

10.3.45 Part 1 of BS5228 sets out techniques to predict the likely noise effects from construction works, based on detailed information on the type and number of plant items being used, their location and the length of time they are in operation.

10.3.46 The noise prediction methods can be used to establish likely noise levels in terms of the $L_{Aeq,T}$ over the core working day. This standard also documents a database of information, including previously measured sound pressure level data for a variety of different construction plant undertaking various common activities.

10.3.47 Three example methods are presented for determining the significance of construction noise impacts. In summary, these methods adopt either a series of fixed noise level limits, are concerned with ambient noise level changes as a result of the construction operations or a combination of the two.

10.3.48 With respect to absolute fixed noise limits, those detailed within *Advisory Leaflet 72: 1976: Noise control on building sites* are presented. These limits are presented according to the nature of the surrounding environment, for a 12-hour working day. The presented limits are:

- 70 dB(A) in rural, suburban and urban areas away from main road traffic and industrial noise; and
- 75 dB(A) in urban areas near main roads and heavy industrial areas.

10.3.49 The above noise level limits are applicable at the façade of the receptor in question (not free-field).

10.3.50 The standard provides methods for determining the significance of construction noise levels by considering the change in the ambient noise level that would arise as a result of the construction operations. Two example assessment methods are presented, these are the 'ABC method' as summarised within Table 10.1 and the '5 dB(A) change' method as described in paragraph 10.3.51.

Table 10.1 – Example threshold of potential significant effect at dwellings (construction noise) – ABC method

Assessment Category and Threshold Value Period	Threshold Value, in Decibels (dB) ($L_{Aeq,T}$)		
	Category (A)	Category (B)	Category I
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends (D)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. *NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.* *NOTE 3: Applied to residential receptors only*			
A) Category A: threshold values to use when ambient levels (when rounded to the nearest 5 dB) are less than these values. *B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.* *C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.* *D) 19.00-23.00 weekdays, 13.00-23.00 Saturdays and 07.00-23.00 Sundays*			

10.3.51 Regarding the '5 dB(A) change' method, the guidance states:

"Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB L_{Aeq}, from construction noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant impact."

BS4142:2014+A1:2019 – Methods for Rating and Assessing Industrial and Commercial Sound

10.3.52 BS4142 is applicable for use in the assessment of control building / substation and transformer noise. It sets out a method for rating and assessing sound of an industrial and/or commercial nature, including "sound from fixed installations which comprise mechanical and electrical plant and equipment".

10.3.53 The assessment procedure contained within BS4142 requires that initially the 'rating level' ($L_{Ar,Tr}$) that is (or would be) generated by the source under assessment is determined, externally, at the assessment location. Where this source does not include any acoustic features, such as tonality, impulsivity or intermittency etc., then the rating level equals the specific sound level (L_s), which is the sound pressure level produced by the source using the $L_{Aeq,T}$ noise index. Where the source under assessment does include acoustic characteristics, then a series of corrections are added to the specific sound level to determine the rating level. The degree of correction applied to determine the rating level depends upon the results of either subjective or objective appraisals.

10.3.54 The background sound level at the assessment location, measured using the $L_{A90,T}$ index, is then subtracted from the rating level. The result provides an indication of the magnitude of impact, where the greater the difference, the greater the magnitude of impact.

10.3.55 The following guidance is presented regarding the difference between the rating and background levels:

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

10.3.56 The degree of impact is also dependent upon the context in which the sound arises. Factors that are considered with respect to context include: the absolute level of sound, and the character and level of the residual sound (that in absence of the source under assessment) compared to the character and level of the specific sound.

10.3.57 With regard to the absolute level the guidance states, that "*where background sound levels and rating levels are low, absolute levels might be as, or more relevant than the margin by which the rating level exceeds the background. This is especially true at night*".

10.4 Consultation

10.4.1 Table 10.2 provides a summary of consultations undertaken with relevant regulatory bodies, together with action undertaken by the Applicant in response to consultation feedback. Copies of relevant consultation correspondence are included in **Appendix 10.1**.

Table 10.2 – Consultation Undertaken

Consultee	Consultation response	Application action
OIC – direct consultation with Environmental Health Department	03/02/22 – ITPEnergised provided preliminary 35 dBL_{A90} noise contour to agree study area and method of baseline survey, including survey locations.	03/02/22 – OIC responded to confirm agreement of proposed approach and provided further guidance on baseline measurement requirements. OIC further confirmed that a cumulative noise assessment would be required as part of the final assessment.
	03/03/22 – ITPEnergised provided a written and photographic record of the installation of baseline monitoring positions.	09/03/22 – OIC confirmed no concerns or queries relating to baseline monitoring.

Consultee	Consultation response	Application action
	22/04/22 – ITPEnergised provided detailed proposed method for deriving residual noise limits at identified representative properties.	No action required
	11/05/22 – Call with ITPEnergised and OIC. Discussion of criteria for financial involvement of receptor properties and invited any further comment on proposed method. OIC noted that methods applied are robust and noted that confirmation of financially involved status is a planning/legal matter, not for Environmental Health to decide.	No action required.

10.5 Assessment Methodology and Significance Criteria

Consultation

10.5.1 A summary of consultation undertaken is provided in Table 10.2 and a full record of email correspondence is provided in **Appendix 10.1**.

Study Area

10.5.2 The study area for this assessment has been informed by maps and aerial images of the Proposed Development site and its surroundings, as well as site visits undertaken during the baseline noise survey. A sample of the closest, and therefore potentially most affected, noise sensitive receptors (NSRs) to the Proposed Development has been identified and adopted for the evaluation of noise impacts. These have been selected to represent a geographic spread across the local area, including those located between the Proposed Development and the considered cumulative developments. NSRs at which noise limits have been set for cumulative developments have been identified for the evaluation of potential cumulative effects. NSRs identified are either single dwellings or representative of a group or cluster of dwellings.

10.5.3 Determination of the study area for a wind farm typically requires that the 35 dBL_{A90} noise contour is predicted, and NSRs which lie beyond the contour are assumed to meet the most stringent ETSU noise limit and are therefore scoped out and discounted from further consideration. NSRs which are identified within the 35 dBL_{A90} noise contour are scoped in, and noise impacts are assessed further.

10.5.4 The 35 dBL_{A90} operational noise contour for the Proposed Development in isolation (i.e. without cumulative developments) at the wind speed at which the proposed turbines generate their maximum sound power level, is shown in **Figure 10.1**. This predicted contour does not include any corrections for concave topography or for the visibility of the turbines from receptor locations and is intended only as a screening tool. **Figure 10.1** shows that 18 potential NSRs lie within or close to the 35 dB noise contour.

10.5.5 In addition to these NSRs, this assessment has considered NSRs beyond the 35 dB contour which may be affected by noise from cumulative developments, both operational and consented/proposed. A review of potentially cumulative developments has been undertaken and properties which lie between the Proposed Development and cumulative developments have been identified. These have been included as NSR19 to NSR25.

10.5.6 The representative NSRs considered in the assessment are listed in Table 10.3 and shown in **Figure 10.1**.

Table 10.3 – Identified Representative NSRs

NSR name	NSR ID	Grid reference (OSGB)	
		Easting	Northing
Veltan (FI)	NSR1	330276	1027681
Dale (FI)	NSR2	330314	1027784
Belmont (FI)	NSR3	330118	1027887
Lochside Cottage (FI)	NSR4	330334	1028205
Stoneymilders (FI)	NSR5	329898	1028130
Newhouse (FI)	NSR6	329564	1028114
Myres*	NSR7	329430	1027816
Nisthouse (FI)	NSR8	329691	1026842
Mucklehouse (FI)	NSR9	330077	1026616
Hundland (FI)	NSR10	330092	1026550
Skesquoy	NSR11	330260	1025820
Dale Costa	NSR12	331928	1027666
Lochview	NSR13	331928	1027174
Bokieha	NSR14	329495	1028364
Kelowna	NSR15	329444	1028379
Viewforth	NSR16	329372	1028419
Finties	NSR17	329273	1028322
Slinghorn	NSR18	329178	1028366
Whitemire	NSR19	332491	1026789
Hewin	NSR20	333609	1027478
Castlehill	NSR21	334777	1026539
Mannobreck	NSR22	329588	1029290
Swannay House	NSR23	329597	1029253
Surtidale	NSR24	330140	1028985
Crismo Farm	NSR25	331507	1028835

Note – properties marked (FI) are considered to be Financially Involved with the Proposed Development.

10.5.7 The identified NSRs are the closest properties in each direction from the Proposed Development.

10.5.8 The property 'Myres' (NSR7) has been confirmed to be derelict and uninhabitable but is included in the analysis for completeness.

Cumulative Operation

10.5.9 Potentially cumulative wind developments, comprising single turbines, turbine clusters and wind farms have been identified within the vicinity of the Proposed Development. Cumulative noise has therefore been considered at a selection of representative NSRs. Where the difference in noise level at a given NSR between the Proposed Development and other developments is 10 dB or greater, cumulative effects will be negligible.

10.5.10 Nearby developments which have been evaluated for potential cumulative effect with the Proposed Development are listed in Table 10.4 and shown in **Figure 10.1**.

Table 10.4 – Potentially Cumulative Developments Identified

Development name	Turbine type(s) and hub height(s)	Approximate distance and direction from Proposed Development
Newhouse	Evance 90–0 - 15m	840 m to north
Nisthouse	Evance 90–0 - 15m	530 m to south-west
Mucklehouse	2x Evance 90–0 - 15m	430 m to south-west
Dale Farm	2x Kinsgpan 6kW	350 m to north-east
Ludenhill	Windflow 5–0 - 30m	180 m – within Proposed Dev.
Costa Head	4x Vestas V1–2 - 69m	2,400 m to north
Burgar Hill	2x Nordex N–0 - 60m 1x Nordex N–0 - 46m 1x MM92 – 70m 1x MM1500 – 60m	2,800 m south-east

Baseline survey

10.5.11 A noise survey was undertaken at three locations to characterise baseline noise levels at representative NSRs within the study area. The noise monitoring positions (NMPs) used are provided in Table 10.5, described and detailed within **Appendix 10.2** and shown on **Figure 10.1**.

Table 10.5 – Baseline Noise Monitoring Positions

NMP name	NMP ID	Grid reference (OSGB)	
		Easting	Northing
Myres	NMP1	329410	1027824
Hundland	NMP2	330092	1026550
Lochview	NMP3	331928	1027270

10.5.12 The baseline survey was completed over the period 1st March to 22nd March 2022.

10.5.13 The sound level meters (SLMs) used were compliant with Class 1 specification, as described in BS EN 61672-1:2003. The calibration of the SLMs was checked in the field before and after each measurement and no significant drift in calibration was noted. The SLMs and the calibrator used were within their accredited laboratory calibration period of two years and one year, respectively. Calibration certificates for the SLMs and calibrator are provided in **Appendix 10.2**.

10.5.14 The SLMs were installed at the monitoring positions each with a microphone at a height of approximately 1.5 m above ground in a free-field location, i.e., at least 3.5 m from any vertical sound reflective surfaces. The microphones were fitted with double-skin outdoor wind shields with a minimum 200 mm diameter.

10.5.15 The monitoring locations are described as follows:

- NMP1 Myres – SLM installed within the garden area of the property, to the west of the house/outbuilding. The SLM was sited more than 3.5 m from any façades, and as distant from trees and bushes as could be achieved; nearby vegetation was noted to be bare of leaves both at the start and end of the survey. A rain gauge was installed adjacent to the SLM. Weather conditions during installation were mostly dry, clear, with moderate to high wind speeds.
- NMP2 Hundland – SLM installed to the south of the house, positioned such that the SLM was at least 3.5 m away from any facades and as far away from vegetation as could be achieved; nearby vegetation was noted to be bare of leaves both at the start and end of the survey. Weather conditions during installation were dry, clear, with moderate to high wind speeds. This property is potentially exposed to noise from two nearby small turbines (the Hundland turbines) and the more distant Ludenhill turbine. The SLM was therefore installed at a representative location at which all of the turbines were screened by the farm buildings. No turbine noise was audible at the monitoring position during the site visit, however the Hundland turbines were clearly audible at nearby locations which were not screened by farm buildings. This is a positive indication that noise from the closest turbines was effectively screened out at the monitoring location.
- NMP3 Lochview – SLM installed in a field immediately to the north of the property 'Lochview'. The SLM was sited more than 3.5 m away from any façades and there was no vegetation in the surrounding area. Weather conditions during installation were dry, clear, with moderate to high wind speeds. The SLM was installed within approximately 5 m of the boundary of the garden of the closest dwelling.

10.5.16 A full record of the installation was provided to the EHO following the commissioning visit and the EHO confirmed that the locations used were acceptable. Full details of the monitoring locations and photographs of the equipment in-situ are provided in **Appendix 10.2**.

10.5.17 Wind speed data was gathered using a Lidar device, sited on Hundland Hill at approximate coordinates: 330535, 1027323. Wind speeds were measured at multiple heights above the local ground level of 80 m, including at the proposed hub height of 102 m.

Construction Phase Noise

On-site Construction Activities, Method of Prediction

10.5.18 A detailed breakdown of the construction schedule and plant for the Proposed Development is not currently available. Drawing on our experience of previous wind farm development, the following assumptions have been made in the prediction of construction noise:

Working hours

- 07.00-19.00 Monday – Fridays;
- 07.00-13.00 Saturdays; and
- No working Sundays and Bank holidays.

Construction plant:

Access tracks and turbine hardstandings

- 4 x road wagons (BS 5228 Table C11, Item 4)

- 1 x 35T excavator (BS 5228 Table C6, Item 7)
- 2 x 6T dump trucks (BS 5228 Table C4, Item 3)
- 1 x 12T bulldozer (BS 5228 Table C2, Item 13)
- 1 x 12T roller (BS 5228 Table C2, Item 38)

Turbine bases and borrow pits

- 1 x 35T excavator (BS 5228 Table C6, Item 7)
- 1 x concrete pump (BS 5228 Table C4, Item 28)
- 2 x cement trucks (BS 5228 Table C4, Item 27)

Turbine installation

- 1 x 400T crane (BS 5228 Table C4, Item 38)
- 1 x road wagon (BS 5228 Table C11, Item 4)

Other assumptions

- all plant has been assumed to operate continuously (100 % utilisation) throughout the working hours;
- all plant has been placed at the closest approach of construction works to the closest NSRs – Turbine Pad 2 and the access track to the west of Hundland Hill;
- noise levels have been predicted in accordance with the BS 5228 prediction method; and
- construction plant has been assumed to have an effective height of 2 m above local ground level.

10.5.19 The closest NSRs to the assumed worst-case construction activities are NSR8 and NSR9. Noise levels, and therefore the magnitude of impacts associated with construction activities, will be lesser at NSRs further from the Proposed Development, therefore noise impacts associated with the construction phase have been evaluated using predicted levels at NSR8 and NSR9 only.

Derivation of Construction Phase Noise Limits

10.5.20 The predicted site preparation / construction noise levels have been assessed based on noise level criteria determined following a worst-case interpretation of the guidance contained within BS5228. As detailed within Section 10.3, BS5228 details three example methods for determining the significance of potential construction noise impacts. Regarding the presented absolute noise level criteria (example method 1), following a worst-case approach, the lowest absolute noise level criterion for the daytime period (07:00 to 19:00) is 70 dB(A) façade, (equivalent to 67 dB(A) free field), which is stated to apply in rural areas.

10.5.21 Following the ABC assessment method, the most stringent assessment criterion (Category A), applies during the daytime (07:00 to 19:00 weekdays and 07:00 to 13:00 Saturdays) where the prevailing ambient noise levels are below 65 $dBL_{Aeq,T}$. Where Category A applies, the allowable noise levels arising from construction noise is 65 dB(A). Assuming an ambient noise level of 32 dB(A) at wind speeds not exceeding 5 ms^{-1}, (NMP2, daytime period) the allowable 'construction only' noise level is 65 $dBL_{Aeq,T}$.

10.5.22 Regarding the 5 dB(A) change method, the allowable construction noise level during the daytime is 65 dB(A), or higher where the resulting ambient noise level change would be less than +5 dB(A). Accordingly, the most stringent allowable 'construction only' noise level following this approach is 65 dB(A). Applying the ABC method or the 5 dB change method therefore gives the most stringent daytime construction noise level criterion of 65 $dBL_{Aeq,T}$.

10.5.23 Criteria have been derived drawing on the above and are provided in Table 10.9.

Operational Phase Noise

General Method of Prediction

10.5.24 A detailed noise model has been prepared for the site and surrounding area, including the adopted NSRs. This model was prepared using the CadnaA® noise modelling software. The model was set to use the ISO 9613 prediction method, which includes prescribed methods for accounting for the effects of geometric divergence, ground absorption, and atmospheric absorption, in accordance with the requirements of ETSU-R-97 and the IoA GPG.

10.5.25 Whilst the IoA GPG presents methodologies for the determination of additional corrections to account for propagation directivity, which could be used for example to account for the effects of wind direction where a receptor is located between two developments, such corrections have not been included within this assessment. The predicted operational noise levels can therefore be considered worst-case in this regard.

10.5.26 The noise model was configured to ensure noise level predictions in compliance with the IoA GPG, including the following:

- Ground absorption: G=0.5;
- Receptor Height: 4 m;
- A correction from $L_{Aeq,T}$ to $L_{A90,T}$ of -2 dB was applied;
- No acoustic screening from buildings or topography was included in the calculated noise levels (worst-case);
- Temperature: 10°C; and
- Humidity: 70%.

10.5.27 The requirement to apply valley corrections and topographic screening corrections was determined with reference to the IoA GPG. Valley corrections have been determined on a turbine-by-turbine basis for all identified NSRs using proprietary software within Geographic Information System (GIS) software. Where topographic screening has been determined to be applicable, no valley correction has been applied, since it is assumed that if the turbine is fully screened at the NSRs, then any concavity determined to lie between the turbine and the NSR will not result in constructive acoustic reflections.

10.5.28 It has been determined that no corrections for screening or concavity will apply at any NSR for the Proposed Development.

Details of the Proposed Development

10.5.29 The noise assessment is based on the Siemens Gamesa SG155 6.6MW, which has a serrated trailing edge of the turbine blades to reduce noise. The source noise terms of the SG155 have been provided by Siemens Gamesa as octave band data, quoted as sound power levels over a range of operational hub-height wind speeds. This may not be the final turbine chosen for the Proposed Development, but the Applicant will ensure any change in turbine meets the noise levels detailed within this assessment.

10.5.30 The octave band data has been standardised to 10 m height wind speeds, and an appropriate uncertainty correction of 2 dB has been applied to the sound power levels in accordance with the requirements of the IoA GPG. The resultant A-weighted sound power levels for the SG155 are provided in Table 10.6.

Table 10.6 – Reported Sound Power Levels of the Siemens Gamesa SG155

Wind speed, ms_{-1}	Sound power level (including +2 dB uncertainty) standardised to 10 m height wind speed, dB(A)
4	99.8
5	104.7
6	107.0
7	107.0
8	107.0
9	107.0
10	107.0
11	107.0
12	107.0

10.5.31 Octave band spectral data for the turbine is provided in Table 10.7.

Table 10.7 – Octave Band Spectrum at $8ms^{-1}$

Octave band centre frequency, Hz	63	125	250	500	1000	2000	4000	8000
Sound power level, dB	84.6	92.0	96.6	98.9	98.7	99.0	92.4	77.4

10.5.32 The proposed turbine layout is provided in **Figure 10.1**.

Cumulative Noise

10.5.33 A review was undertaken of existing and proposed wind energy developments in the vicinity of the site, using information available on the OIC planning portal and in consultation with Environmental Health. This review has been completed to identify those developments which have the potential to give rise to a cumulative noise impact when operating simultaneously with the Proposed Development. The results of this desk-based review have been used to inform the assessment of operational turbine noise. The identified cumulative developments are provided in Table 10.4.

10.5.34 Where two predicted noise levels differing by 10 dB or more are summed, the total level is the same as the larger of the two levels; i.e. the lower level contributes a negligible amount to the total. This principle has been used to determine the cumulative study area for this assessment, and to identify which turbines contribute cumulatively to the Proposed Development.

10.5.35 The predicted level from the Proposed Development was compared with the predicted level from potentially cumulative developments, corrected where necessary such that they met their consented noise limits for each NSR at wind speeds of 4 ms^{-1} to $12ms^{-1}$. Where a difference of 10 dB or greater was identified, cumulative effects between developments were excluded from further consideration. This process is shown in **Appendix 10.4**.

10.5.36 The process provided in the IoA GPG for the determination of Residual Noise Limits (RNLs) has been followed for each NSR. In each case an Overall Noise Limit (ONL) has been adopted, either from baseline data at an appropriate proxy location or with reference to consented noise limits for cumulative developments. RNLs have been determined according to the presence of significant presented headroom and either subtraction of a cautious prediction for cumulative developments or subtraction of 10 dB where headroom is not present. The process is shown in full for each NSR in **Appendix 10.4**.

Assessment of Potential Effect Significance

10.5.37 The impact magnitude and effect significance have been determined following the criteria described in the assessment of potential effect significance section below.

Receptor Sensitivity

10.5.38 The guidance contained within Technical Advice Note to PAN 1/2011 has been drawn upon in the generation of an appropriate set of significance criteria. The receptor sensitivity criteria for the construction, operational and decommissioning phases of the Proposed Development are presented within Table 10.8.

Table 10.8 – Noise and Vibration Receptor Sensitivity Criteria

Receptor Sensitivity	Description	Examples
High	Receptors where people or operations are particularly susceptible to noise and/or vibration.	Residential, quiet outdoor recreational areas, schools and hospitals.
Medium	Receptors moderately sensitive to noise and/or vibration, where it may cause some distraction or disturbance.	Offices and restaurants.
Low	Receptors where distraction or disturbance from noise and/or vibration is minimal.	Buildings not occupied, factories and working environments with existing levels of noise.

Impact Magnitude – Construction Noise

10.5.39 The construction noise impact magnitude has been determined according to the threshold levels provided in Table 10.9

Table 10.9 – Impact Magnitude Criteria for Noise from Construction Activities - Weekday Daytimes (08:00 – 18:00) and Saturdays 08:00 – 12:30

Difference (d) between predicted construction noise level and applicable limit (65 $dBL_{Aeq,1hr}$), dB	Impact magnitude
d > +5	High
0 < d ≤ +5	Medium
-10 < d ≤ 0	Low
d ≤ -10	Negligible

Impact Magnitude – Construction Traffic

10.5.40 Criteria for the evaluation of road traffic noise effects based on changes to the BNL of roads in the vicinity of the Proposed Development in accordance with DMRB are provided in Table 10.10.

Table 10.10 – Evaluation Criteria for Noise from Construction Traffic

Increase (i) over existing BNL due to construction traffic flows, $dBL_{10,18hr}$	Impact magnitude
i ≥+5	High
3 ≤ i < +5	Medium
1 ≤ i < +3	Low
0 ≤ i < +1	Negligible

Impact Magnitude – Operational Wind Turbine Noise

10.5.41 The significance of operational wind turbine noise has been determined solely by reference the proposed noise limits, as set out in paragraph 10.5.44.

Impact Magnitude – Fixed (non-turbine) Plant Noise

10.5.42 For noise from any fixed (non-turbine) plant such as transformers, control buildings or substations, it is appropriate to determine significance criteria based on the guidance contained within BS4142, i.e. by consideration of the difference between the rating level from the plant noise and the prevailing background sound levels, but also with respect to context and the resulting sound levels in absolute terms.

10.5.43 The impact magnitudes associated with noise generated from fixed plant are presented in Table 10.11.

Table 10.11 – Impact Magnitude for Fixed (non-turbine) Plant Noise

Difference, d, between Rating Level ($L_{Ar,Tr}$) and Background Sound Level (L_{A90})	BS4142 Guidance	Impact Magnitude
d >+10	Indication of significant adverse impact	High
d >+5, ≤10	Indication of adverse impact	Medium
d ≤ 0, >-10	Indication of low Impact	Low
d ≤-10	-	Negligible
Where the rating level ($L_{Ar.Tr}$) is below 35dB the impact magnitude is classified as 'Negligible' regardless of the relationship to the background noise level. *+ indicates rating level above background noise level* *- indicates rating level below background noise level*		

Effect Significance – Operational Wind Turbine Noise

10.5.44 The significance of operational wind turbine noise has been determined only with reference to the proposed ETSU-R-97 noise limits as follows:

- This assessment considers that compliance with the proposed noise limits at NSRs will demonstrate operational wind turbine noise is "not significant"; and
- This assessment considers that operational wind turbine noise levels above the proposed noise limits at NSRs will be "significant".

Effect Significance

10.5.45 The effect significance for construction, road traffic and operational (non-turbine) fixed plant noise has been determined by consideration to both the receptor sensitivity and the impact magnitude according to the matrix detailed in Table 10.12.

Table 10.12 – Effect Significance Matrix

Impact Magnitude	Receptor Sensitivity		
	High	**Medium**	**Low**
High	Major	Moderate	Minor
Medium	Moderate	Minor	Neutral
Low	Minor	Neutral	Neutral
Negligible	Neutral	Neutral	Neutral

10.5.46 This assessment considers all identified NSRs to be of "high" sensitivity in accordance with Table 10.9, given that they are residential dwellings. This assessment considers that effects with a significance of "moderate" and "major" are significant and effects with a significance of "neutral" and "minor" are not significant.

Requirements for Mitigation

10.5.47 Consideration has been given to available mitigation measures to reduce adverse effects and enhance beneficial effects. Where mitigation measures are detailed, these are committed to by the Applicant and have been determined through professional judgement and the implementation of best practice.

Assessment of Residual Effect Significance

10.5.48 Residual effects have been assessed following the methods described above but taking into account the committed mitigation measures.

Limitations to Assessment

10.5.49 Detailed information on techniques and equipment for the construction phase of the Proposed Development is not currently available. Consequently, appropriate and robust assumptions have been made regarding the nature of likely construction activities and plant, and noise predictions made accordingly. It is therefore anticipated that predicted noise levels represent the "worst case" potential construction noise levels.

10.5.50 It was not possible to determine the contribution of existing cumulative turbines to baseline noise levels at the NMPs by analysis of baseline data. The contribution of these turbines has instead been determined by prediction, using appropriately robust methods and assumptions, where appropriate.

10.5.51 The assessment of operational impacts associated with the wind turbines has been undertaken adopting source noise levels for the Siemens Gamesa SG155. Following completion of the tendering process, it is possible that the precise turbine make / model adopted and / or the operational mode will change from that adopted within the assessment. It is noted, however, that the final turbine model chosen will be selected to ensure compliance with the derived noise level limits.

10.6 Baseline Conditions

Wind Conditions

10.6.1 Wind speed data was checked for quality on receipt. All wind speeds <1 ms^{-1} were excluded from further analysis.

10.6.2 A wind rose of measured wind speeds and directions derived to 10 m above ground level over the period of the baseline survey is provided in Chart 10.1 in **Appendix 10.3**. With reference to Chart 10.1, the most commonly occurring wind speeds were in the range 5 ms^{-1} – 10 ms^{-1} and the most prominent wind directions were southerly through to south-easterly with infrequent westerlies. Wind from the north and north-east occurred for less than 5 percent of the time.

Description of Baseline Noise Environment

10.6.3 Time-history charts of the measured ambient[1] (L_{Aeq}) and background[2] (L_{A90}) noise levels for each monitoring location are provided in **Appendix 10.3**.

8.1.1

[1] *Ambient level – the equivalent continuous sound pressure level of the totally encompassing sound in a given situation at a given time, usually from multiple sources, at the assessment location over a given time interval, T.*

[2] *Background level - the A-weighted sound pressure level that is exceeded for 90 percent of a given time interval, T. The background level is unaffected by short-duration, noisy events, and is therefore representative of the lowest-occurring noise levels in a given noise environment. This noise index is used in the evaluation of the baseline noise environment, and predicted noise levels from wind turbines in wind farm noise assessments.*

10.6.4 Charts showing the measured background noise levels correlated with wind speed, and divided into Quiet Daytime and Night-time periods, in accordance with ETSU, are provided in **Appendix 10.3** for all three NMPs. The proposed hub height of 102 m was used to derive the standardised 10 m wind speed for correlation with background noise levels. The charts show the wind-dependent background noise level, the 'background +5 dB' criterion and the derived noise limits. Rainfall-affected data has been screened out, in accordance with the IoA GPG (i.e. with the periods preceding and after the recorded rainfall also excluded). A wind rose for the location is provided in **Appendix 10.3**.

NMP1 - Myres

Description of baseline noise environment

10.6.5 The dominant noise source observed during the installation was the wind, with lesser contributions from bird calls, and very infrequent road traffic movements.

10.6.6 A time-history graph of measured ambient and background levels, wind speed and rainfall events is provided as Chart 10.2 in **Appendix 10.3**. With reference to Chart 10.2, the following observations are noted regarding measured baseline noise levels:

- the ambient and background levels show a close correlation throughout the majority of the measurement period; this is indicative of a fairly constant noise source such as wind-induced noise, rather than intermittent anthropogenic activities; and
- there is no clear diurnal variation and the primary control on noise levels is attributed to weather conditions, rather than time of day.

Corrections applied to measured background noise levels

10.6.7 Notes on representative background derivation:

- The SLM was installed to the west of the building at Myres and, as such, it would have been screened from noise from the Ludenhill turbine (NMP1 was 1,250m from Ludenhill turbine) and predictions support this assumption. No correction to account for Ludenhill turbine has therefore been applied.
- The Dale Farm turbines are approximately 660m from NMP1 and were screened by the building therefore no correction has therefore been applied to measured levels for these turbines.
- The Hundland turbines (T1, T2) and Nisthouse turbine are between 1.1km and 1.3km from NMP1 and will have had a negligible contribution to measured background levels. No correction has been made for these turbines.
- There is an Evance 9000 turbine at Newhouse which was 440m from NMP1. This turbine has been modelled and the predicted noise level from this turbine has been logarithmically subtracted from the measured background levels recorded at NMP1 at each wind speed.
- No directional filtering has been applied to measured background levels such that measured levels represent all wind directions.

10.6.8 The regression analysis showing the derivation of daytime and night-time background levels and the noise limits from NMP1 baseline data is shown in Chart 10.4 and Chart 10.5, respectively.

NMP2 – Hundland

Description of baseline noise environment

10.6.9 The dominant noise sources observed during the installation were the wind and, to a lesser extent, waves on the Loch of Hundland; the wind was westerly at the time of installation and was therefore coming across the loch towards the monitoring location.

10.6.10 A time-history graph of measured ambient and background levels, wind speed and rainfall events is provided as Chart 10.3 in **Appendix 10.3**. With reference to Chart 10.3, the following observations are noted regarding measured baseline noise levels:

- the ambient and background levels show a close correlation throughout the majority of the measurement period, indicative of a fairly constant noise source; and
- there is no clear diurnal variation and the primary control on noise levels is attributed to weather conditions, rather than time of day.

Corrections applied to measured background noise levels

10.6.11 Notes on representative background derivation:

- The SLM was installed to the south-east of the farm buildings and the house at Hundland and, as such, it would have been screened from noise from the Hundland turbines and Nisthouse turbine. Predictions which consider screening by buildings support this. No correction to account for contributions from the Nisthouse and Hundland turbines have therefore been applied.
- Noise from the Ludenhill turbine 600m to the north has been predicted at NMP2, excluding any screening from buildings (a robust approach, as NMP2 was on the opposite side of the house from the Ludenhill turbine) and the predicted level logarithmically subtracted from measured background noise levels for each wind speed. There is no reported sound power data for the Ludenhill turbine for 4m/s wind speed, so the 5m/s value was used at 4m/s in a robust approach.
- Noise from other existing turbines will be negligible at NMP2, based on attenuation due to distance – this is supported by predictions.
- No directional filtering has been applied to measured background levels such that measured levels represent all wind directions.

10.6.12 The regression analysis showing the derivation of daytime and night-time background levels and the noise limits from NMP2 baseline data is shown in **Appendix 10.3** in Chart 10.6 and Chart 10.7, respectively.

NMP3 – Lochview

Description of baseline noise environment

10.6.13 The dominant noise sources observed during the installation were the wind and waves on the Loch of Swannay; the wind was westerly at the time of installation and was therefore coming across the loch towards the monitoring location.

10.6.14 A time-history graph of measured ambient and background levels, wind speed and rainfall events is provided as Chart 10.4 in **Appendix 10.3**. With reference to Chart 9.3, the following observations are noted regarding measured baseline noise levels:

- the ambient and background levels show a close correlation throughout the majority of the measurement period, indicative of a fairly constant noise source; and

- there is no clear diurnal variation and the primary control on noise levels is attributed to weather conditions, rather than time of day.

Corrections applied to measured background noise levels

10.6.15 Notes on representative background derivation:

- The SLM was installed close to the Loch of Swannay at a location representative of the cottage to the south and Dale to the north.
- The closest existing turbines to NMP3 are:
- Ludenhill 1.5 km to the west;
- Burgar Hill 2.2 km to the south-east; and
- Two small turbines 1.3 km to the north-north-east.
- Noise from the Hundland, Nisthouse and Newhouse turbines will be negligible at NMP3 on account of their separation distances.
- The Burgar Hill turbines are substantially larger than the closer small turbine developments and their contribution may therefore be larger.
- The contribution of the Ludenhill turbine to measured noise levels at NMP3 will have been greatest when it was up-wind of NMP3, i.e. westerly wind directions.
- Burgar Hill and the two small turbines to the north of NMP3 will have had the greatest contribution to measured noise levels when they were up-wind of NMP3, i.e. northerlies, easterlies to southerlies, and will have a negligible contribution during westerlies.
- The noise data from NMP3 has been filtered to exclude wind directions from 0° (northerlies) through 90° (easterlies) to 180° (southerlies), leaving data from 180° through 270° to 0° (westerlies). This approach will suppress noise from the two small turbines to the north and Burgar Hill to a negligible level at NMP3; this is supported by predictions. Under these wind conditions these NSRs will be down-wind of both the Proposed Development and the Loch of Swannay, therefore this approach is considered robust.
- The predicted level from the Ludenhill turbine at NMP3 has been logarithmically subtracted from the measured background level under westerly wind conditions to give the background level in the absence of noise from existing cumulative turbines. The level for the Ludenhill turbine was predicted at 4m above ground level, considering a ground absorption of G=0 (acoustically reflective surface) for the Loch of Swannay, in accordance with the requirements of the IoA GPG.

10.6.16 The regression analysis showing the derivation of daytime and night-time background levels, correction for noise from existing turbines and the derivation of noise limits from NMP3 baseline data is shown in **Appendix 10.3**. Chart 10.8 and Chart 10.9, respectively, show the measured background level under all wind directions. Chart 10.10 and Chart 10.11 show the measured background level when NMP3 was down-wind of the Ludenhill turbine for the daytime period and the night-time period, respectively.

Method for Derivation of Residual Noise Limits

10.6.17 Following the removal of potential turbine noise from the baseline data, the following process was followed to derive residual noise limits (RNLs) for each NSR:

- Noise limits at NSRs applicable to other cumulative developments were identified, identification of controlling properties:

- Consented noise limits were reviewed for Costa Head, Burgar Hill and the various small turbine developments;
- Costa Head names specific NSRs and presents tabulated numerical noise limits across a range of wind speeds; these have been included within the analysis;
- For Burgar Hill there are general background-derived limits and although properties are not specified these are assumed to apply at the closest residential properties to Burgar Hill; and
- The small turbines use the simplified ETSU 35 dBLA90 flat noise limit and exclude financially-involved properties.
- Correction of predicted noise levels from cumulative developments to meet consented limits at controlling properties:
- Where predicted levels from cumulative developments (operating in isolation) exceeded the consented limits at the closest properties or named controlling property the noise output of the cumulative development was corrected within the noise model such that the noise limits of the specific development were met; and
- Only the predicted level for Burgar Hill required this correction, given the conservative assumptions made regarding the sound power level of the Burgar Hill turbines in the noise model.

10.6.18 Identification of the Overall Noise Limit (ONL) applicable at each NSR:

- The adopted ONLs at NSRs named in the Costa Head consented limits are the tabulated Costa Head noise limits provided in its planning consent;
- The adopted ONLs at all other NSRs are those derived in accordance with ETSU-R-97 from the corrected, measured background levels; and
- The ONLs will consider whether NSRs are Financially Involved (FI) with the proposed development. Properties considered to be FI with the Proposed Development are indicated in Table 10.3.

10.6.19 Cumulative developments were identified at each NSR:

- At each NSR the predicted worst-case (i.e. down-wind) noise level for each potentially cumulative development was subtracted from the worst-case (down-wind) predicted level for the proposed development;
- Where the difference was ≥10 dB no cumulative effects will occur and the potentially cumulative development has been discounted for the specific NSR;
- Where the difference was <10 dB cumulative effects may occur and the potentially cumulative development has been included within cumulative calculations at this NSR.

10.6.20 The presence or absence of significant headroom was identified, and RNLs applicable specifically to the Proposed Development were derived for each NSR:

- The predicted worst-case cumulative noise level (assuming down-wind propagation) was subtracted from the ONL and headroom was considered to be present where the difference was ≥5 dB;
- Where significant headroom of ≥5 dB was identified, the RNL was determined by subtraction of a 'cautious prediction' (predicted level +2dB) of cumulative turbines from the ONL;

- Where significant headroom was not identified (i.e. <5 dB), the RNL was determined by subtraction of 10 dB from the ONL.
- This stage assumes that the Nisthouse, Newhouse and Hundland small turbines will be switched off at wind speeds of 9ms^{-1} to 12ms^{-1} (further detail provided in paragraph 10.7.3).

The approach set out above follows the method provided in the IoA GPG.

10.6.21 The application of proxy measurement data from NMPs to NSRs is shown in Table 10.13.

Table 10.13 – Application of Proxy Data to NSRs

NMP Proxy Data Applied in Derivation of ONLs	NSRs at Which Proxy Data Applied
NMP1	NSR1, NSR2, NSR3, NSR4, NSR5, NSR6, NSR7, NSR14, NSR15, NSR16, NSR17, NSR18
NMP2	NSR8, NSR9, NSR10, NSR11
NMP3	NSR12, NSR13
Burgar Hill consented noise limits	NSR19, NSR20, NSR21
Costa Head consented noise limits	NSR22, NSR23, NSR24, NSR25

10.6.22 The ONLs, and the process of derivation of RNLs is shown in **Appendix 10.3** and the resultant RNLs applicable at each NSR are provided in Table 10.14. The proxy NMP data applied to NSRs shown in Drawing 10.2.

Table 10.14 – Derived RNLs at all NSRs

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Residual Noise Limit, $dBL_{A90,10min}$								
Daytime period									
NSR1	44.6	44.7	45.0	45.0	45.0	44.2	43.8	43.3	43.3
NSR2	44.8	44.8	45.0	45.0	45.0	45.0	44.3	44.1	44.1
NSR3	44.8	44.9	45.0	45.0	44.8	44.7	44.5	44.3	44.3
NSR4	44.9	44.9	44.8	44.7	44.7	44.7	44.7	44.7	44.7
NSR5	44.9	45.0	44.9	44.6	44.5	44.4	44.1	43.9	43.9
NSR6	44.8	44.8	44.6	44.2	43.8	43.1	44.8	44.8	44.8
NSR7	44.9	45.0	45.0	45.0	45.0	45.0	45.0	44.8	44.8
NSR8	44.6	44.5	44.5	44.1	43.5	45.0	45.0	46.2	48.2
NSR9	44.4	44.6	45.0	44.4	44.0	44.4	44.4	45.7	47.9
NSR10	44.6	44.7	45.0	44.6	44.3	43.2	42.1	44.1	46.7
NSR11	34.2	34.4	34.4	36.8	38.9	41.4	43.8	46.1	48.1
NSR12	35.5	36.1	36.7	37.4	39.3	41.1	43.1	45.1	47.0

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Residual Noise Limit, $dBL_{A90,10min}$								
NSR13	35.3	36.6	37.2	37.7	39.4	41.2	43.2	45.1	47.0
NSR14	34.1	33.4	34.0	34.5	36.3	37.9	39.3	40.7	42.0
NSR15	34.2	33.7	34.3	35.0	36.9	38.5	39.9	41.3	42.5
NSR16	34.4	34.1	34.9	35.4	37.3	39.0	40.4	41.8	42.8
NSR17	34.5	34.3	35.2	36.2	37.6	39.3	40.7	42.0	43.0
NSR18	34.6	34.3	35.2	36.3	38.0	39.4	40.9	42.1	43.1
NSR19	33.8	33.7	36.9	37.9	38.9	39.9	41.2	40.9	40.9
NSR20	34.9	32.5	35.5	36.5	37.5	41.0	42.0	42.0	42.0
NSR21	35.0	35.0	38.0	39.0	40.0	41.0	42.0	42.0	42.0
NSR22	33.4	25.6	27.8	40.0	42.2	44.2	44.2	44.1	44.1
NSR23	33.4	25.6	27.8	30.0	32.2	42.2	42.1	42.1	42.1
NSR24	36.3	38.4	40.3	42.9	45.9	45.9	45.8	45.8	45.8
NSR25	34.2	34.4	35.5	38.1	41.5	44.4	46.7	46.7	46.7
Night-time period									
NSR1	44.6	44.7	45.0	45.0	45.0	44.2	43.8	43.3	43.3
NSR2	44.8	44.8	45.0	45.0	45.0	45.0	44.3	44.1	44.1
NSR3	44.8	44.9	45.0	45.0	44.8	44.7	44.5	44.3	44.3
NSR4	44.9	44.9	44.8	44.7	44.7	44.7	44.7	44.7	44.7
NSR5	44.9	45.0	44.9	44.6	44.5	44.4	44.1	43.9	43.9
NSR6	44.8	44.8	44.6	44.2	43.8	44.8	44.8	44.8	44.8
NSR7	44.9	45.0	45.0	45.0	45.0	45.0	45.0	44.8	44.8
NSR8	44.6	44.5	44.5	44.1	43.5	45.0	45.0	45.5	47.8
NSR9	44.4	44.6	45.0	44.4	44.0	44.4	44.4	44.9	47.4
NSR10	44.6	44.7	45.0	44.6	44.3	44.5	44.5	45.0	47.5
NSR11	42.9	42.9	42.9	43.0	42.9	42.9	42.9	45.4	47.7
NSR12	42.9	42.9	42.9	42.7	42.7	45.8	48.6	50.9	52.3
NSR13	42.9	43.0	43.0	42.8	42.8	45.8	48.6	50.9	52.3
NSR14	42.9	42.8	42.7	42.4	42.2	42.0	41.6	41.3	42.6
NSR15	42.9	42.8	42.7	42.5	42.4	42.2	42.0	41.8	43.0
NSR16	42.9	42.9	42.8	42.6	42.5	42.4	42.3	42.2	43.3

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Residual Noise Limit, $dBL_{A90,10min}$								
NSR17	42.9	42.9	42.8	42.7	42.6	42.6	42.5	42.4	43.4
NSR18	42.9	42.9	42.8	42.7	42.7	42.6	42.6	42.6	43.6
NSR19	33.8	33.7	36.9	37.9	38.9	39.9	41.2	40.9	40.9
NSR20	34.9	32.5	35.5	36.5	37.5	41.0	42.0	42.0	42.0
NSR21	35.0	35.0	38.0	39.0	40.0	41.0	42.0	42.0	42.0
NSR22	42.8	42.4	41.5	43.0	43.0	43.0	43.4	43.3	43.3
NSR23	42.8	42.5	41.6	40.2	40.2	40.1	40.8	40.8	40.8
NSR24	42.7	42.3	41.3	33.0	41.5	41.5	41.4	41.3	41.3
NSR25	42.9	42.8	42.6	42.2	43.5	43.5	43.5	43.4	43.4

10.7 Standard Mitigation

Construction Phase

10.7.1 Good practice measures will be implemented during construction to limit unnecessary noise including but not limited to the following:

- avoid unnecessary revving of engines and switching off plant when not required (i.e. no idling);
- haul routes to be kept well maintained;
- minimising the drop height of materials during delivery to, and movement around, site;
- starting up plant and vehicles sequentially, rather than all together;
- specification of plant with white-noise or directional reversing alarms, rather than beeper type alarms;
- where possible, selection of quiet / noise reduced plant;
- vehicles accessing the site will have regard to the normal operating hours of the site and the location of nearby NSRs. Deliveries will be scheduled to minimise unnecessary disturbance; and
- use and siting of equipment will be considered such that noise is minimised. For example, any generators or powered cabins within the construction compound will be sited such that noise from the generator exhaust is directed away from the closest NSRs, and cabins and other infrastructure are used to screen noise from such plant wherever possible.

Operational Phase

Fixed (non-turbine) plant noise

10.7.2 Noise from non-turbine operational plant will comprise noise from substations only. The sound power level and final location of the substation(s) are yet to be finalised, however, noise from the final type and location of the substation will be attenuated by acoustic enclosure (if required), such that it meets the derived non-turbine noise limits (see paragraph 10.9.7). A total sound power level

of 100 dB(A), equivalent to a sound pressure level of 72 dB(A) at 10 m, would enable the noise limit to be met. The installed plant will meet these criteria.

Wind turbine noise

10.7.3 Agreements will be in place with the owners/operators of the Nisthouse, Hundland and Newhouse turbines that these turbines will be switched off at wind speeds of 9 ms^{-1} and above to preserve headroom for operation of the Proposed Development.

10.8 Receptors Brought Forward for Assessment

10.8.1 The NSRs listed in Table 10.3 have been considered in this assessment.

10.9 Potential Effects

Construction

Construction Traffic

10.9.1 Observations noted during the baseline noise survey confirmed that road traffic forms a very minor component of the noise environment within the study area.

10.9.2 With reference to **Chapter 11** projected construction traffic flows on the Nisthouse Road and Hundland Road during the peak construction traffic flows, daily vehicle movements respectively, equivalent to increases over the projected future baseline flows of 786 % and 97 %, respectively. While the percentage increases are large, the total number of vehicle movements per day on both of these roads remains below the 50 vehicles per hour minimum threshold for calculation of noise for low traffic flow roads provided in CRTN. Traffic flows can therefore be considered very low. This assessment therefore assumes that the total noise level due to roads affected by construction traffic, at the closest NSRs, will see an increase of up to 3 dB, equivalent to a doubling of the road traffic noise, in any given hour. Despite the change in noise levels, the equivalent $L_{Aeq,18hr}$ traffic noise level is expected to remain low and the increase is considered unlikely to be at a level which would cause disturbance.

10.9.3 With reference to Table 10.10, an increase of up to 3 dB corresponds to a low impact magnitude. With reference to Table 10.12, the resultant effect significance is **minor**, and is therefore not significant.

On-site Construction

10.9.4 The highest of the predicted noise levels at NSR8 and NSR9, the closest properties to the Proposed Development site, are provided and evaluated against the adopted noise limit (refer to parapgraph 10.5.22) in Table 10.15 for each of the three stages of construction considered.

Table 10.15 – Evaluation of worst-case construction phase noise levels at closest NSRs

Scenario	Predicted level, $dBL_{Aeq,T}$	Comparison with noise limit (predicted level minus 65 dB), dB
Construction of access tracks	56	-9
Construction of turbine bases	54	-11
Installation of turbines	49	-16

10.9.5 At the closest NSRs to the Proposed Development; NSR8 and NSR9, predicted worst-case noise levels due to construction activities meet the adopted noise limits by a margin of 9 dB or greater. With reference to Table 10.9 the impact magnitude is **negligible,** therefore with reference to Table 10.12 the effect significance is Neutral, and construction noise effects are therefore not significant.

Operation

Fixed (non-turbine) plant noise

10.9.6 The Proposed Development will include a substation which will generate noise, which will potentially be tonal in nature. No details are currently available on the source noise levels of the substation, and it is therefore considered appropriate that suitable noise control limits will be set to which any such ancillary plant items will be required to conform. The noise limits apply to the rating level, which includes any corrections for acoustic characteristics, such as tonality and intermittency, in accordance with the BS4142 method.

10.9.7 Based on representative background noise levels of 30 dBL_{A90} at wind speeds up to 5 ms^{-1}, this assessment adopts the rating level noise limit of 35 dB at any identified NSR, equivalent to the baseline background noise levels at NMP2. Provided that the noise limit is met by all non-turbine plant, including the substation, with reference to Table 10.11 the impact magnitude will be Low. At high sensitivity NSRs, the resultant effect significance will be **minor** and therefore not significant.

Wind turbine noise

10.9.8 Predicted noise levels due to operation of the Proposed Development are provided in Table 10.16 across the wind speed range 4 ms^{-1} – 12ms^{-1}.

Table 10.16 – Predicted Wind Turbine Noise Levels due to Proposed Development

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level, dBL_{A90}								
NSR1	33.6	38.7	42.1	42.7	42.7	42.7	42.7	42.7	42.7
NSR2	32.6	37.7	41.1	41.7	41.7	41.7	41.7	41.7	41.7
NSR3	31.4	36.5	39.9	40.5	40.5	40.5	40.5	40.5	40.5
NSR4	28.2	33.3	36.7	37.3	37.3	37.3	37.3	37.3	37.3
NSR5	28.6	33.7	37.1	37.7	37.7	37.7	37.7	37.7	37.7
NSR6	27.7	32.8	36.2	36.8	36.8	36.8	36.8	36.8	36.8
NSR7	30.1	35.2	38.6	39.2	39.2	39.2	39.2	39.2	39.2
NSR8	32.7	37.8	41.2	41.8	41.8	41.8	41.8	41.8	41.8
NSR9	34.8	39.9	43.3	43.9	43.9	43.9	43.9	43.9	43.9
NSR10	33.8	38.9	42.3	42.9	42.9	42.9	42.9	42.9	42.9
NSR11	25.9	31.0	34.4	35.0	35.0	35.0	35.0	35.0	35.0
NSR12	25.9	31.0	34.4	35.0	35.0	35.0	35.0	35.0	35.0
NSR13	28.4	33.5	36.9	37.5	37.5	37.5	37.5	37.5	37.5
NSR14	25.2	30.3	33.7	34.3	34.3	34.3	34.3	34.3	34.3
NSR15	24.9	30.0	33.4	34.0	34.0	34.0	34.0	34.0	34.0
NSR16	24.3	29.4	32.8	33.4	33.4	33.4	33.4	33.4	33.4
NSR17	24.5	29.6	33.0	33.6	33.6	33.6	33.6	33.6	33.6

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level, dBL_{A90}								
NSR18	23.8	28.9	32.3	32.9	32.9	32.9	32.9	32.9	32.9
NSR19	22.3	27.4	30.8	31.4	31.4	31.4	31.4	31.4	31.4
NSR20	16.2	21.3	24.7	25.3	25.3	25.3	25.3	25.3	25.3
NSR21	12.1	17.2	20.6	21.2	21.2	21.2	21.2	21.2	21.2
NSR22	19.6	24.7	28.1	28.7	28.7	28.7	28.7	28.7	28.7
NSR23	19.8	24.9	28.3	28.9	28.9	28.9	28.9	28.9	28.9
NSR24	22.0	27.1	30.5	31.1	31.1	31.1	31.1	31.1	31.1
NSR25	21.9	27.0	30.4	31.0	31.0	31.0	31.0	31.0	31.0

10.9.9 The predicted worst-case (down-wind propagation) noise levels are evaluated against the RNLs for each NSR in Table 10.17.

Table 10.17 – Evaluation of Predicted Wind Turbine Noise Levels due to Proposed Development Against RNLs

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level minus RNL, dB								
Daytime period									
NSR1	-9.7	-4.9	-2.9	-2.9	-2.9	-2.1	-1.7	-1.2	-1.2
NSR2	-10.9	-6.0	-3.9	-3.9	-3.9	-3.9	-3.2	-3.0	-3.0
NSR3	-12.1	-7.3	-5.1	-5.1	-4.9	-4.8	-4.6	-4.4	-4.4
NSR4	-15.4	-10.5	-8.1	-8.0	-8.0	-8.0	-8.0	-8.0	-8.0
NSR5	-15.1	-10.3	-7.9	-7.6	-7.5	-7.4	-7.1	-6.9	-6.9
NSR6	-15.8	-10.9	-8.4	-8.0	-7.6	-6.9	-8.6	-8.6	-8.6
NSR7	-13.6	-8.8	-6.5	-6.5	-6.5	-6.5	-6.5	-6.3	-6.3
NSR8	-10.7	-5.7	-3.4	-3.0	-2.4	-3.9	-3.9	-5.1	-7.1
NSR9	-8.4	-3.7	-1.8	-1.2	-0.8	-1.2	-1.2	-2.5	-4.7
NSR10	-9.5	-4.7	-2.7	-2.3	-2.0	-0.9	0.2	-1.8	-4.4
NSR11	-7.1	-2.4	-0.1	-2.5	-4.6	-7.1	-9.5	-11.8	-13.8
NSR12	-8.4	-4.1	-2.4	-3.1	-5.0	-6.8	-8.8	-10.8	-12.7
NSR13	-5.7	-2.1	-0.4	-0.9	-2.6	-4.4	-6.4	-8.3	-10.2
NSR14	-7.7	-2.1	-0.4	-0.9	-2.7	-4.3	-5.7	-7.1	-8.4

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level minus RNL, dB								
NSR15	-8.1	-2.7	-1.0	-1.7	-3.6	-5.2	-6.6	-8.0	-9.2
NSR16	-8.9	-3.7	-2.2	-2.7	-4.6	-6.3	-7.7	-9.1	-10.1
NSR17	-8.7	-3.6	-2.2	-3.2	-4.6	-6.3	-7.7	-9.0	-10.0
NSR18	-9.6	-4.4	-3.0	-4.1	-5.8	-7.2	-8.7	-9.9	-10.9
NSR19	-10.3	-5.3	-6.2	-7.2	-8.2	-9.2	-10.5	-10.2	-10.2
NSR20	-17.6	-10.3	-11.0	-12.0	-13.0	-16.5	-17.5	-17.5	-17.5
NSR21	-22.0	-17.1	-17.8	-18.8	-19.8	-20.8	-21.8	-21.8	-21.8
NSR22	-12.6	0.1	0.2	-12.0	-14.2	-16.2	-16.2	-16.1	-16.1
NSR23	-12.4	0.3	0.4	-1.8	-4.0	-14.0	-13.9	-13.9	-13.9
NSR24	-13.0	-10.2	-9.8	-12.4	-15.4	-15.4	-15.3	-15.3	-15.3
NSR25	-11.1	-6.4	-5.2	-7.8	-11.2	-14.1	-16.4	-16.4	-16.4
Night-time period									
NSR1	-9.7	-4.9	-2.9	-2.9	-2.9	-2.1	-1.7	-1.2	-1.2
NSR2	-10.9	-6.0	-3.9	-3.9	-3.9	-3.9	-3.2	-3.0	-3.0
NSR3	-12.1	-7.3	-5.1	-5.1	-4.9	-4.8	-4.6	-4.4	-4.4
NSR4	-15.4	-10.5	-8.1	-8.0	-8.0	-8.0	-8.0	-8.0	-8.0
NSR5	-15.1	-10.3	-7.9	-7.6	-7.5	-7.4	-7.1	-6.9	-6.9
NSR6	-15.8	-10.9	-8.4	-8.0	-7.6	-8.6	-8.6	-8.6	-8.6
NSR7	-13.6	-8.8	-6.5	-6.5	-6.5	-6.5	-6.5	-6.3	-6.3
NSR8	-10.7	-5.7	-3.4	-3.0	-2.4	-3.9	-3.9	-4.4	-6.7
NSR9	-8.4	-3.7	-1.8	-1.2	-0.8	-1.2	-1.2	-1.7	-4.2
NSR10	-9.5	-4.7	-2.7	-2.3	-2.0	-2.2	-2.2	-2.7	-5.2
NSR11	-15.8	-10.9	-8.6	-8.7	-8.6	-8.6	-8.6	-11.1	-13.4
NSR12	-15.8	-10.9	-8.6	-8.4	-8.4	-11.5	-14.3	-16.6	-18.0
NSR13	-13.3	-8.5	-6.2	-6.0	-6.0	-9.0	-11.8	-14.1	-15.5
NSR14	-16.5	-11.5	-9.1	-8.8	-8.6	-8.4	-8.0	-7.7	-9.0
NSR15	-16.8	-11.8	-9.4	-9.2	-9.1	-8.9	-8.7	-8.5	-9.7
NSR16	-17.4	-12.5	-10.1	-9.9	-9.8	-9.7	-9.6	-9.5	-10.6
NSR17	-17.1	-12.2	-9.8	-9.7	-9.6	-9.6	-9.5	-9.4	-10.4
NSR18	-17.9	-13.0	-10.6	-10.5	-10.5	-10.4	-10.4	-10.4	-11.4

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level minus RNL, dB								
NSR19	-10.3	-5.3	-6.2	-7.2	-8.2	-9.2	-10.5	-10.2	-10.2
NSR20	-17.6	-10.3	-11.0	-12.0	-13.0	-16.5	-17.5	-17.5	-17.5
NSR21	-22.0	-17.1	-17.8	-18.8	-19.8	-20.8	-21.8	-21.8	-21.8
NSR22	-22.0	-16.7	-13.5	-15.0	-15.0	-15.0	-15.4	-15.3	-15.3
NSR23	-21.8	-16.6	-13.4	-12.0	-12.0	-11.9	-12.6	-12.6	-12.6
NSR24	-19.4	-14.1	-10.8	-2.5	-11.0	-11.0	-10.9	-10.8	-10.8
NSR25	-19.8	-14.8	-12.3	-11.9	-13.2	-13.2	-13.2	-13.1	-13.1

Note – red text indicates predicted level above RNL

10.9.10 Predicted noise levels meet the derived RNLs at all NSRs at all wind speeds by a margin of 0.1 dB up to 22.0 dB, with the exception of NSR22 and NSR23 at 5ms^{-1} and 6 ms^{-1} during the daytime period, where exceedances of up to 0.2 dB and 0.4 dB have been identified, respectively.

10.9.11 Excluding NSR22 and NSR23 at 5ms^{-1} and 6 ms^{-1} noise effects at these NSRs and these wind speeds during the daytime period are not significant.

10.9.12 Predicted noise levels meet the derived RNLs at all NSRs at all wind speeds during the night-time period by a margin of 0.8 dB up to 22.0 dB. Noise effects at all NSRs across the range of wind speeds during the night-time period are therefore not significant.

10.9.13 At NSR22 and NSR23 at 5ms^{-1} and 6 ms^{-1} the predicted noise levels exceed the daytime RNL by up to 0.4 dB and therefore appear to be significant (adverse). Given very small margin by which the predicted level exceeds the RNL and the robust nature of the prediction method, actual overall noise levels are likely to be lower than the predicted levels, and no mitigation will be required. The Proposed Development will therefore meet the RNLs across the full range of wind speeds. This assessment therefore considers that noise levels at NSR22 and NSR23 at 5ms^{-1} and 6 ms^{-1} will meet the daytime noise limits and operational wind turbine noise is not significant.

10.9.14 The Applicant commits to compliance with appropriate noise limits, therefore should actual noise levels at NSR22 and NSR23 be above the noise limit, then appropriate mitigation will be put in place such that noise limits are met.

Decommissioning

10.9.15 *The Proposed Development has an anticipated 40-year operational lifespan.* Noise impacts during decommissioning will be similar to those during the construction phase, however, decommissioning is typically of shorter duration and will involve fewer items of heavy plant. Noise impacts at the closest NSRs during decommissioning have therefore been assessed as having a magnitude of Low (adverse) with a resultant effect significance of **minor** and are not significant.

10.10 Additional Mitigation and Enhancement

10.10.1 No specific additional mitigation is proposed, however, as noted in paragraph 10.9.14, the Applicant has committed to meeting the proposed RNLs. Once operational, should noise levels due to the Proposed Development be determined to be above the proposed noise limits, then a Noise Management Plan would be put in place to reduce noise levels such that the noise limits are met. The Noise Management Plan would set out the conditions (wind speed and direction) under which exceedances had been identified and the methods used to reduce operational noise, potentially

including operation of a specific turbine or turbines in low noise mode or switching the turbine(s) off.

10.11 Residual Effects

Construction

10.11.1 No requirement for specific additional mitigation (beyond good practice measures) has been determined for the construction phase, therefore no additional mitigation is proposed, and residual effects remain unchanged, and are therefore not significant. No cumulative effects are anticipated during the construction phase, and cumulative noise effects are therefore considered to be not significant.

Operation

Fixed non-turbine plant

10.11.2 No additional mitigation is required for fixed non-turbine plant, therefore residual effects remain unchanged, and are therefore not significant.

Noise from wind turbines

10.11.3 As noted above, the Applicant is committed to meeting the proposed noise limits of the Proposed Development. Following selection and procurement of the final turbine model, and implementation of an appropriate turbine noise management plan, if required, it is anticipated that operational wind turbine noise levels will meet the derived noise limits at all NSRs across the full range of wind speeds, both during the daytime and the night-time periods.

10.11.4 With reference to paragraph 10.9.14, no specific mitigation is currently proposed, as the Proposed Development is expected to meet the RNLs at all NSRs.

Decommissioning

10.11.5 No requirement for specific additional mitigation (beyond good practice measures) has been determined for the decommissioning phase, therefore no additional mitigation is proposed, and residual effects remain unchanged, and are therefore not significant. No cumulative effects are anticipated during the decommissioning phase, and cumulative noise effects are therefore considered to be not significant.

10.12 Cumulative Assessment

Construction

9.1.1 No cumulative effects are anticipated during the construction phase, and cumulative noise effects are therefore considered to be not significant.

Operational noise

8.1.1 Given the presence of existing cumulative wind turbines, the Proposed Development will not operate in isolation. The approach taken in Section 10.9 comprising the apportionment of the daytime and night-time ONLs to derive appropriate RNLs considers the ability of the Proposed Development to meet noise limits which account for the existing noise from cumulative developments. No additional assessment of cumulative effects is therefore required.

10.13 Summary

10.13.1 An assessment of potential noise effects has been carried out for the construction, operation and decommissioning stages of the Proposed Development.

10.13.2 Construction noise will be limited in duration and confined to working hours as specified by OIC and can therefore be adequately controlled through planning condition. The application of mitigation measures where applicable will also ensure that any noise from site will be adequately controlled.

10.13.3 The operational assessment has been undertaken in accordance with the recommendations of ETSU-R-97, the method of assessing wind turbine noise recommended by Government guidance, and following the current best practice methods described in the IoA GPG, as endorsed by Scottish Government. A review of existing noise limits applicable to operational and consented developments has been undertaken and a baseline noise survey completed, and ONLs defined according to the IoA GPG's recommendations. These have been used to derive RNLs which will apply to the Proposed Development only.

10.13.4 This assessment demonstrates that noise due to the Proposed Development would comply with the RNLs, subject to the existing small turbines of properties financially involved with the Proposed Development being switched off at wind speeds of 9 ms^{-1} and above. Marginal (<0.5 dB) exceedances of the proposed RNLs have been identified at two NSRs, at two wind speeds, however, given the conservatism of the prediction method, actual operational noise levels will be lower and it is unlikely that additional mitigation will be required. The Applicant is, however, committed to meeting the RNLs, and will put in place mitigation should this be demonstrated to be required by compliance measurements.

Table 10.18 – Summary of Effects

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Construction					
Noise from construction activities	Minor	Adverse	Implementation of appropriate noise controls regarding hours of work, timing of site deliveries, and use of best practice to minimise unnecessary noise	Minor	Adverse
Noise from construction traffic	Minor	Adverse	Implementation of appropriate noise controls regarding hours of work, timing of site deliveries, and use of best practice to minimise unnecessary noise	Minor	Adverse
Operation					
Noise from non-turbine fixed plant	Minor	Adverse	Selection of plant which complies with specified maximum sound power level such that the derived noise limits are met.	Minor	Adverse

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Noise from wind turbines	Not significant	Adverse	Small turbines associated with Nisthouse, Newhouse and Hundland will be switched off at wind speeds of 9 ms^{-1} and above to preserve headroom for the Proposed Development to operate. Not significant evaluation considered based on the conservatism of the prediction method. Predicted noise level at NSR22 and NSR23 is marginally above proposed RNL however, such exceedances are not anticipated to occur in practice.	Not significant	Adverse
Decommissioning					
Noise from decommissioning activities	Minor	Adverse	Implementation of appropriate noise controls regarding hours of work, timing of site deliveries, and use of best practice to minimise unnecessary noise	Minor	Adverse

Table 10.19 – Summary of Cumulative Effects

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
All NSRs	Cumulative wind turbine noise – cumulative noise effects will be the same as operation in isolation effects	Small turbines associated with Nishouse, Newhouse, Hundland, Dale and wind farms at Costa Head and Burgar Hill	Not significant	Adverse

10.14 References

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